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Preliminary Cruise Results
NOAA Ship *Miller Freeman*
Cruise No. MF2001-09

Fishery Interaction Study:
Echo Integration-Trawl Survey of Walleye Pollock
off the East Side of Kodiak Island, Gulf of Alaska

Cruise Period, Area, and Schedule

Scientists from the Alaska Fisheries Science Center (AFSC) conducted an echo integration-trawl (EIT) survey of walleye pollock (*Theragra chalcogramma*) off the east side of Kodiak Island over Chiniak and Barnabas Troughs. The work was conducted aboard the NOAA ship *Miller Freeman* from August 9 to 31, 2001 (20 sea days). The cruise began and ended in Kodiak, Alaska. No commercial trawling operations were allowed in Chiniak and Barnabas Troughs when the *Miller Freeman* conducted the first and second survey passes through the troughs. Commercial trawling operations had resumed in Barnabas Trough when the *Miller Freeman* conducted its third and fourth passes of Chiniak and Barnabas troughs.

The vessel's itinerary was as follows:

Aug 9	Embark scientists in Kodiak, Alaska
Aug 9-14	Conduct first pass of EIT survey in Chiniak and Barnabas Troughs
Aug 14-19	Conduct second pass of EIT survey in Chiniak and Barnabas Troughs
Aug 20-22	Inport Kodiak
Aug 23-29	Conduct third pass of EIT survey in Chiniak and Barnabas Troughs
Aug 29-30	Conduct fourth pass of EIT survey in Barnabas Trough, and conduct fish avoidance research with acoustic buoy
Aug 30	Acoustic sphere calibration in Ugak Bay
Aug 31	Disembark scientists; end of cruise

Objectives

The primary cruise objective was to collect echo integration data, and midwater and bottom trawl data to determine the distribution, biomass, and biological composition of walleye pollock in Chiniak and Barnabas Troughs. Secondary objectives were to:

1. calibrate the 38- and 120-kHz scientific acoustic systems using standard sphere techniques;

2. collect physical oceanographic data (temperature and salinity profiles) at selected sites, and continuously collect sea surface temperature, salinity, and water current profiles;

3. collect age-1 and age-2 pollock to assess whether these cohorts are vertically segregated in the Gulf of Alaska;

4. collect age-0 pollock to compare length-specific weight, diet, and otolith-derived age and growth data;

5. collect fish species preyed upon by Steller sea lions (*Eumatopias jubatus*) to determine levels of fat, protein, and calories to construct bioenergetic models to assess how changes in prey abundance and distribution affect sea lions;

6. collect stomachs from pollock, Pacific cod (*Gadus macrocephalus*), and arrowtooth flounder (*Atheresthes stomias*) for food habits studies; and

7. collect acoustic data with a buoy to determine the behavior of walleye pollock in response to ship noise.

Methods

Sampling Equipment

Acoustic data were collected with a Simrad EK500[1] quantitative echo-sounding system on board the NOAA ship *Miller Freeman*, a 66-m (216-ft) stern trawler equipped for fisheries and oceanographic research. The Simrad 38-kHz and 120-kHz split-beam transducers were mounted on the bottom of the vessel's centerboard. With the centerboard fully extended, the transducers were 9 m below the water surface. System electronics were housed inside the vessel in a permanent laboratory space dedicated to acoustics. Data from the echo sounder were post-processed using Simrad BI500 echo integration and target strength data analysis software on a SUN workstation. Results presented in this document were based on the 38-kHz data.

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[1] Reference to trade names of commercial firms does not constitute U.S. Government endorsement.

Midwater echosign was sampled with an Aleutian Wing 30/26 trawl (AWT), a full-mesh wing trawl constructed of nylon except for polyethylene toward the aft section of the body and the codend. The headrope and footrope both measured 81.7 m (268 ft). Mesh sizes tapered from 3.25 m (10.7 ft) in the forward section of the net to 8.9 cm (3.5 in) in the codend. A codend liner with a mesh of 1.3 cm (0.5 in) was used. The AWT was fished with 82.3 m (270 ft) of 1.9-cm (0.75-in) diameter 8x19 non-rotational dandylines, 113.6-kg (250-lb) or 227.3-kg (500-lb) tom weights on each side, and 5-m^2 (53.8-ft^2) “Fishbuster” doors [1,250 kg (2,750 lb) each].

Fish on and near bottom were sampled with a polyethylene Nor'eastern (PNE) high-opening bottom trawl equipped with roller gear. The PNE was constructed with stretch mesh sizes that ranged from 13 cm (5 in) in the forward portion of the net to 8.9 cm (3.5 in) in the codend. It was fitted with a nylon codend liner with a mesh size of 3.2 cm (1.25 in). The 27.2-m (89.1-ft) headrope held 21 floats [30-cm (12-in) diameter]. A 24.7-m (81-ft) chain fishing line was attached to the 24.9-m (81.6-ft) footrope which was constructed of 1-cm (0.4-in) 6 × 19 wire rope wrapped with polypropylene rope. The 24.2-m (79.5-ft) roller gear was constructed with 36-cm (14-in) rubber bobbins spaced 1.5 to 2.1 m (5 to 7 ft) apart. A solid string of 10-cm (4-in) rubber disks separated some of the bobbins in the center section of the roller gear. Two 5.9-m (19.5-ft) wire rope extensions with 10-cm (4-in) and 20-cm (8-in) rubber disks were used to span the two lower flying wing sections and were attached to the roller gear. The roller gear was attached to the fishing line using chain toggles [2.9 kg (6.5 lb.) each] which were composed of five links and one ring. The trawl was rigged with triple 54.9-m (180-ft) galvanized wire rope dandylines, and was fished with the “Fishbuster” doors.

A Methot trawl was used to target smaller organisms near surface and midwater. A rigid square frame measuring 2.3 m (7.5 ft) on each side formed the mouth of the net. Mesh sizes were 2 mm × 3 mm (0.08 in × 0.12 in) in the body of the net and 1 mm (0.04 in) in the codend. A 1.8-m (6-ft) dihedral depressor was used to generate additional downward force. A calibrated General Oceanics flow meter was attached to the mouth of the Methot trawl to determine the volume of water filtered during trawling. The Methot trawl was attached to a single cable that was fed through a stern-mounted A-frame.

Headrope depth and vertical net opening of AWT and PNE trawls were monitored with a WESMAR third-wire system or a Furuno wireless netsounder system attached to the headrope. A Scanmar sounder system monitored Methot trawl depths with a depth sensor attached to the Methot trawl frame. Profiles of tow depth and water temperature as a function of depth were obtained for all hauls by attaching a small, retrievable micro bathythermograph (Sea-Bird SBE39 temperature and pressure recorder) to the net. Water temperature and salinity profile data were collected at the acoustic system calibration site and other locations with a Sea-Bird conductivity-temperature-depth (CTD) system. Expendable bathythermograph (XBT) probes were used to collect water temperature profile data at selected locations. Satellite-tracked drifters, which were drogued at 40 m (131.2 ft), were released to document near-surface current flow. Sea surface temperature, salinity, other environmental data, and input for the vessel’s Marine Operations Abstract (MOA) were collected and stored on the *Miller Freeman*'s Scientific Computing System (SCS). Ocean current profile data were obtained using the vessel-mounted acoustic Doppler current profiler system operating continuously in water-profiling mode. Vessel pitch, roll, and heave data were collected with a TSS Position and Orientation System for Marine Vessels (POS/MV Model 320) to monitor transducer motion.

A drifting buoy containing an echosounder, associated equipment, and two hydrophones suspended at nominal depths of 92 m (301.8 ft) and 107 m (351.0 ft) was deployed and recovered during the survey on an opportunistic basis. After the buoy was released in an area over fish echosign, the vessel steamed 1.8-3.6 km (1-2 nmi) from the buoy and maintained that distance until the scientist in charge notified the bridge to begin free-running at normal survey speed along a course that took the vessel as close as possible past the buoy. The vessel continued steaming until 1.8-3.6 km (1-2 nmi) past the buoy. Multiple passes were run past the buoy.

Survey Methods

Two series of parallel transects, spaced 5.5 km (3 nmi) apart, were used to survey Chiniak and Barnabas Troughs repeatedly (Figs. 1 - 4). Transect endpoints were usually located in the shallower waters along trough edges where backscattering attributed to walleye pollock had declined to undetectable levels. Three survey passes, each consisting of 17 transects totaling 325.7 km (178 nmi), were conducted over Chiniak Trough. Three survey passes, each consisting of 15 transects totaling 485.0 km (265 nmi), were conducted over Barnabas Trough. A fourth, partial pass consisting of the last 9 transects totaling 261.7 km (143 nmi) was also completed over Barnabas Trough.

Primary EIT survey operations, which included the collection of acoustic and trawl data, took place during the 14-15 daylight hours per day. Nighttime activities during the remaining 9-10 hours included re-running portions of the survey track line to evaluate the diel distribution patterns of the dominant scatterers, conducting additional trawl hauls to supplement daytime sampling and to verify nighttime scattering layers, CTD sampling to describe water column properties, and conducting other ancillary scientific projects.

Vessel speed averaged 5.8 m/s (11.4 kts) during acoustic data collection. Echo integration data were collected from 14 m (45.9 ft) below the surface to within 0.5 m (1.6 ft) of the bottom. These data were post-processed by one or more scientists and stored in an INGRES database. When properly scaled, they will be used to provide density estimates for walleye pollock and capelin (*Mallotus villosus*).

Midwater and bottom trawl hauls were made at selected locations to identify echosign and to provide biological data and pollock samples. Haul duration was kept to the minimum necessary to ensure an adequate sample. Average trawling speed was about 1.5 m/s (3 kts). Vertical net opening for the AWT and PNE trawls averaged about 24 m (78.7 ft) and 8 m (26.2 ft), respectively. Catches less than about 1,300 kg (2,860 lb) were completely sorted by species; larger catches were usually subsampled. Total weights and numbers were determined for most species. Weights of the sorted portions from the catch were determined to the nearest 0.1 kg (0.2 lb) using an electronic, motion-compensating scale (Marel M2000, 60-kg [132-lb] capacity). Walleye pollock were subsampled from catches to determine fish fork length composition by sex, as well as to collect otoliths, maturities, individual length-weight measurements, and stomachs. Individual pollock were weighed to the nearest 2 gm (0.1 ounce) using a Marel M2000 6-kg (13.2-lb) capacity scale. Fish fork length (FL) measurements were made to the nearest cm (0.4 in) with a Polycorder measuring device (an integrated bar code reader and a hand-held computer). Standard lengths (SL) to the nearest mm were determined for young-of-the-year pollock and capelin, although total length (TL), SL, and FL measurements to the nearest mm were also made on several samples of capelin. Pollock gonads were examined visually and assigned a stage of maturity based on an internationally accepted 8-point scale. Both otoliths were removed and stored in a solution of 50% ethanol for subsequent age determination. Stomach samples were preserved in 10% formalin.

Preliminary Results

Two standard sphere calibrations of the 38-kHz and 120-kHz scientific acoustic systems were made before and during the survey (Table 1). No substantial differences in system parameters between these and historical calibrations for either the 38-kHz system or the 120-kHz system were observed.

Biological data were collected and samples preserved from 41 midwater trawls, 16 bottom trawls, and 4 Methot trawls (Figs. 1-4, Tables 2-7). Pollock was the predominant species caught in both midwater and bottom trawls with primarily juvenile pollock caught in midwater trawls and adults in bottom trawls. Capelin ranked third by weight and second in numbers in midwater trawls. The 17 midwater trawls that targeted capelin occurred in the vicinity of Cape Chiniak and in the southern portion of Barnabas Trough (i.e., along transects 1-7). Unidentified jellyfish were the second and fourth most common taxonomic group by weight in midwater and bottom trawls, respectively. Large numbers of unidentified squid, eulachon (*Thaleichthys pacificus*), and unidentified shrimp were also caught in midwater trawls. More than 20% of the bottom trawl catch composition was attributed to arrowtooth flounder (*Atheresthes stomias*) and Pacific cod (*Gadus macrocephalus*). Most of the cod by weight was captured in hauls 49 (Chiniak Trough, 564.1 kg) and 35 (mouth of Ugak Bay, 182.8 kg). Large numbers of unidentified shrimp and flathead sole (*Hippoglossoides elassodon*) were also caught in the bottom trawl.

The four Methot trawl hauls were conducted in an attempt to identify the species composition of a nearly continuous scattering layer that occurred within the upper 25 m of the water column in both Chiniak and Barnabas Troughs (Table 3). Catch composition in Methot trawl haul catches consisted of more than 99% jellyfish by weight. A preliminary examination of these catch data did not provide clear evidence to identify the dominant scatterers of this layer.

Acoustic backscattering was classified into primarily three groups: adult pollock, juvenile pollock, and capelin (Figs. 5-16). Adult pollock were located in the northern portion of Barnabas Trough and throughout Chiniak Trough, where they generally formed loose, near-bottom aggregations during the day. Juvenile pollock displayed similar geographical distributions within the two troughs, but usually were shallower in the water column at depths of about 75-150 m during the day. They dispersed broadly at night. Capelin were generally abundant over deeper waters within the southern portion of Barnabas Trough and the shallower waters along the edges of Chiniak Trough, particularly in the vicinity of Cape Chiniak. They, like juvenile pollock, occurred at depths of about 75-150 m during the day and often moved to within 25-75 m of the surface at night.

Pollock size distributions, based on data from trawl hauls that targeted this species, were mostly uni-modal (Fig. 17). Bimodal distributions did occur in some cases when juvenile pollock, which formed a relatively shallow scattering layer, were inadvertently captured during hauls that targeted the deeper scattering layers attributed to the larger adult pollock. Adults, which represented the near-bottom echosign, tended to have a prominent length mode around 55-60 cm. Juvenile pollock, which typically occurred higher in the water column than the adults, were characterized by one-year-old fish with a length mode of around 20 cm. The length-weight regression curve for pollock is shown in Figure 18.

The size distribution for capelin captured in Barnabas suggested a slightly bimodal distribution of relatively larger fish than those captured in Chiniak (Fig. 19). A linear regression was fitted to the capelin length data to describe the relationship among total, fork, and standard fish lengths (Fig 20).

Pollock maturities observed during the survey were dominated by immature, developing, and post-spawning males and females (Fig. 21). No spawning pollock were observed, and only 11 pollock were classified as pre-spawning.

Physical oceanographic data were collected from 61 SBE39 casts associated with trawl hauls (Tables 2 and 3), 48 CTD casts (Table 8; Figs. 22-26), 15 XBT casts (Table 9; Figs. 22-25), and 6 satellite-tracked drifters (Table 10; Figs. 22-24). Water temperatures ranged between about 11°C - 15°C (52°F - 59°F) at the surface and 6°C - 9°C (43°F - 48°F) at depths greater than 120 m (393.7 ft) (Fig. 26).

The acoustic buoy was deployed once over adult walleye pollock. During this daytime deployment, the *Miller Freeman* made six passes within 2-20 m (6-66 ft) of the buoy before the fish echosign disappeared. Analysis of the data is in progress.

SCIENTIFIC PERSONNEL

Name	Sex/ Nationality	Position	Organization
Leg 1:			
Chris Wilson	M/USA	Chief Scientist	AFSC
Christine Brothers	F/USA	Teacher at Sea	OLA
Steve de Blois	M/USA	Fish. Biologist	AFSC
Dale Hanson	M/USA	Fish. Biologist	AFSC

Tucker Jackson	M/USA	Student Intern	AFSC
Phil Porter	M/USA	Computer Specialist	AFSC
Michiyo Shima	F/Japan	Fish. Biologist	UW
Paul Walline	M/USA	Fish. Biologist	AFSC

<u>Leg 2:</u>

Chris Wilson	M/USA	Chief Scientist	AFSC
Julian Burgos	M/Argentina	Student	UW
Steve de Blois	M/USA	Fish. Biologist	AFSC
Dale Hanson	M/USA	Fish. Biologist	AFSC
Anne Hollowed	F/USA	Fish. Biologist	AFSC
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